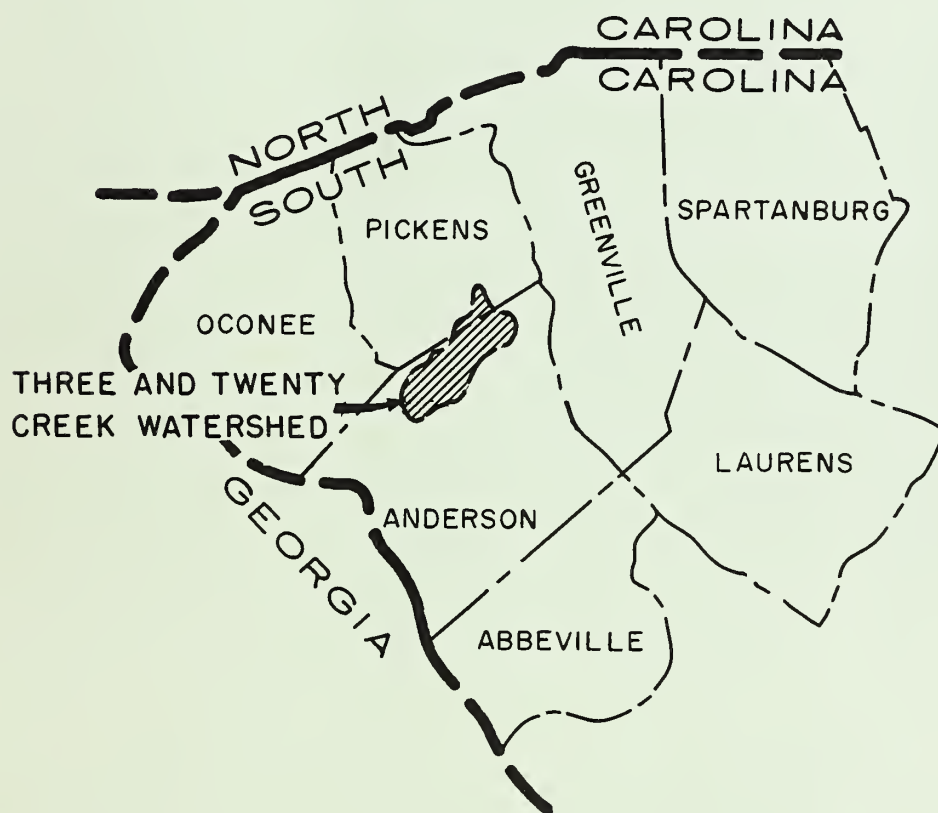


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WATERSHED WORK PLAN THREE AND TWENTY CREEK WATERSHED

ANDERSON AND PICKENS COUNTIES
SOUTH CAROLINA



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

AUGUST 1963

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WATERSHED WORK PLAN

THREE AND TWENTY CREEK WATERSHED

ANDERSON AND PICKENS COUNTIES

SOUTH CAROLINA

Prepared under the Authority of the Watershed
Protection and Flood Prevention Act (Public
Law 566, 83d Congress, 68 Stat. 666) as amend-
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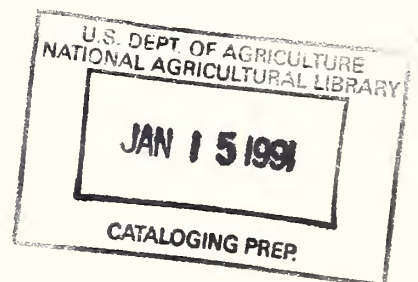
Prepared by: Three and Twenty Creek Watershed Conservation District
Anderson County Soil Conservation District
Pickens Soil Conservation District

With Assistance By:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

August 1963



1. The first part of the report deals with the general situation of the country and the progress of the work during the year. It also mentions the results of the various investigations and the conclusions drawn from them.

2. The second part of the report deals with the results of the various investigations and the conclusions drawn from them. It also mentions the progress of the work during the year and the general situation of the country.

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THE WATERSHED WORK PLAN

THREE AND TWENTY CREEK WATERSHED

ANDERSON AND PICKENS COUNTIES, SOUTH CAROLINA

SUMMARY OF PLAN

The Three and Twenty Creek Watershed comprises an area of 47,590 acres of land in Anderson and Pickens Counties, South Carolina. The project is sponsored jointly by the Three and Twenty Creek Watershed Conservation District, the Anderson County and the Pickens Soil Conservation Districts.

The greater part of the watershed has been in cultivation in former years. Present estimates show about 49 percent of the area to be wooded, and 19 percent being used for crops. Thirty percent is grassland and idle, and 2 percent is classified as miscellaneous.

The flood plain area includes 3,122 acres which are subject to flooding. Overbank flow occurs with an average frequency of 3.8 times per year, and a flood sufficient to inundate one half the flood plain occurs with an average frequency of 1.9 times per year. Because of this flood hazard, only 708 acres or about 23 percent of the flood plain is in agricultural use, and the remainder is idle, or has reverted to brush and low value woods.

The proposed works of improvement to be installed during the five-year installation will consist of land treatment measures, the stabilization of critical silt producing areas in fields and along highways and roads, the construction of improved channels and seven floodwater retarding structures.

The seven floodwater retarding structures and the 105,690 lineal feet of channel improvement will protect 2,034 acres (100 acres is below lower boundary of watershed) of the flood plain to permit the production of truck crops, experimental crops, corn and improved pasture. Simpson Experiment Station of Clemson College is located in the watershed. Approximately 306 acres of flood plain land on this experimental farm will be benefited

by the project. Truck and experimental (Horticultural) crops are planned for the flood plain below structure number 9B. The utilization of the fertile flood plain will result in increased income to farmers. It will permit a change in land use on some of the adjoining upland and is expected to result in the conversion of 2,460 acres to trees and grassland. This land is not suitable for more intensive uses than those planned. There will be no increase in total acreages of controlled crops.

There are 183 landowners who will have portions of their land protected from flooding. Flood plain holdings range in size from one acre to 307 acres.

The present use of the 2,034 acres of flood plain land below proposed structures is as follows: 235 acres of unimproved pasture yielding three animal unit months of grazing per acre, and 1,799 acres of woodland and miscellaneous.

The anticipated use and yields are: 682 acres of corn yielding 65 bushels per acre, 749 acres of improved pasture yielding nine animal unit months of grazing per acre, 67 acres of truck crops, and 536 acres of woods and miscellaneous.

Land treatment measures such as terraces, field ditches, waterways, stock-watering ponds, tree planting, pasture planting and wildlife habitat development will be installed by farmers under conservation farm plans with the Anderson County and the Pickens Soil Conservation Districts. Technical assistance in the planning and application of these measures will be provided by the Soil Conservation Service. The South Carolina Commission of Forestry, with the cooperation of the U. S. Forest Service, will furnish technical assistance for tree planting.

The roadside erosion control and critical area planting will be installed by landowners, or by contract administered by the Three and Twenty Creek Watershed Conservation District.

For estimated needs and cost summary of Land Treatment Measures, see Table 1. These measures are estimated to cost \$500,430, of which \$147,221 will be provided from PL 566 funds and \$353,209 from other funds.

The structural measures, consisting of seven floodwater retarding structures and 105,690 lineal feet of channel improvement are estimated to cost \$1,012,732. Of this, \$827,229 will be provided from PL 566 funds and \$185,503 from other funds. These measures will be installed under contracts administered by the Three and Twenty Creek Watershed Conservation District.

Total project installation cost is estimated to be \$1,513,162, of which \$974,450 will be provided from PL 566 funds and \$538,712 from other funds.

The planned land treatment measures will be maintained by the individual landowners concerned in accordance with the provisions of their respective conservation farm plans with the Anderson County and the Pickens Soil Conservation Districts.

Specific items relating to the operation and maintenance of structural measures are assumed by the Three and Twenty Creek Watershed Conservation District as explained in the section entitled, "Provisions for operation and maintenance". The estimated average annual cost of operation and maintenance is \$13,425.

The average annual benefits resulting from the planned structural measures are \$78.883, see Table 6. The average annual cost amounts to \$45,478, giving a 1.7 to 1.0 benefit-cost ratio for the project.

DESCRIPTION OF THE WATERSHED

Physical Data

Location - The Three and Twenty Creek Watershed is located in Anderson and Pickens Counties, South Carolina. The project area comprises an area of 47,590 acres and is located near the cities of Anderson and Easley and the Town of Pendleton. There are 7,422 acres in Pickens County and 40,168 acres in Anderson County.

Physiography and Geology - The watershed is located in the Piedmont plateau physiographic province. Topography is typically Piedmont in character with a rolling landscape in the headwaters giving way to more pronounced relief in more highly dissected areas toward the mouth of the creek. Granite, possibly, of Carboniferous age, is the predominant rock type. No major structural features, such as folds and faults, were observed.

Soils - The predominant residual soils are those of the Cecil and Lloyd series. Many of these soils have been subjected to degrees of erosion varying from moderate to severe with the most severe erosion having occurred in the upper portion of the watershed. In general, these soils are deep, well-drained, and moderately high in natural fertility. Infiltration rates are moderate except in areas of severe erosion. Bottom-land soils generally are moderate to high in inherent fertility.

Climate - The watershed is located in an area in which a warm, moist climate prevails. Although extended cold periods are rare, below freezing temperatures are not uncommon. During the summer months, daytime temperatures in the high 90s are not unusual. Long-term mean temperatures at the Anderson weather station are 45.5° F and 79.6° F for the months of January and July, respectively, and 61° F for the year. Often, there is a considerable departure from long-term mean precipitation which ranges from a low of 2.67 inches in September to 5.18 inches in March and amounts to 47.26 inches for the year.

Water Courses - The drainage pattern is dendritic with Three and Twenty Creek flowing in a general southwesterly direction to discharge into Twenty Six Mile Creek and later into the Seneca River. Tributaries are numerous and the system is in the Savannah River basin.

Water Uses and Sources - Water for irrigation and livestock is obtained from streams and farm ponds. Water for domestic use on farms is obtained primarily from wells. Ground and surface water supplies are more than sufficient to supply existing and anticipated requirements.

Fish and Wildlife - Fishing resources in the watershed are negligible. Wildlife resources consist of moderate populations of forest and farm game species. Rabbits, doves, quail, and squirrel furnish most of the hunting in this area.

Land Use - At the time of work plan preparation there were an estimated 8,837 acres in cultivation, 14,183 acres in pasture or idle, 23,619 acres in trees, and 951 acres in miscellaneous use. The cultivated land is used for the production of cotton, pasture, small grain, corn, silage crops, hay, orchard and truck crops.

Forest Land - The condition of the 23,619 acres of forest is a key factor in the control of flood producing runoff in the watershed. The present effectiveness of the upland forest and soil in regulating the behaviour of the surface runoff is poor compared to its potential. Eighty percent of the forest soil is in poor condition.

Forest land grazing, wildfires, and past cultivation of new forest areas combined to retard the development of water absorbent soils. Ninety-two percent of the forest land was under cultivation within the last fifty years. Many of the forest stands were repeatedly overcut, leaving poor quality or unmerchantable species in the present stands. The result is that the merchantable volume is less than one-fifth of that expected under a good management program.

The present trend is toward the improvement of the woodlands. The woodlands are provided management assistance and fire protection by the South Carolina Commission of Forestry, in cooperation with the U. S.

Forest Service. The present level of forest fire protection and suppression is adequate. The present trend shows a decrease in woodland grazing.

Economic Data

The Town of Hasley lies just north of the watershed and the City of Anderson is seven miles to the south. Part of the Town of Pendleton and the textile village of LaFrance are included in the watershed.

It is estimated that about sixty-two percent of the income in the watershed is from agriculture. Agricultural activity in the watershed consists of the production of cotton, pasture, small grain, corn, silage crops, hay, orchard and truck crops. Cotton acreage has been on the decline for a number of years.

There are 691 farms in the watershed. The average farm contains 68 acres and is valued at \$9,890. Most of these farms are operated by the owners.

The population of the watershed is about 4,500. Of this number, approximately 3,500 live on farms and the remaining 1,000 live in Pendleton and LaFrance.

At the present time, 8,837 acres are in cultivation, 14,183 acres are in either pasture or idle, 23,619 acres are in woods and 951 acres are in miscellaneous use.

Forest products are produced in small quantity. The forest land in the watershed is owned by small farmers. The present level of fire protection is considered adequate but better management is needed to improve the quality of stands.

The watershed area is served by a railroad and by Federal, State and County highways.

Although neither Anderson nor Pickens County was designated as a Rural Areas Development County under the Area Redevelopment Act of 1961, it is expected that farm income in the low income rural areas will be improved by the project. The 1959 U. S. Census of Agriculture, adjusted to the watershed, shows that less than 40 percent of the farms are considered as commercial farms. This indicates that above 60 percent of the farmers in the watershed are non-commercial and had total sales of less than \$2,500.

Commercial farms are divided into six economic classes on the basis of the total value of all farm products sold, as follows:

<u>Class of Farm</u>	<u>Value of Farm Products Sold</u>	<u>Percentage of Farms Classified in Watershed</u>
Class I	\$40,000 and over	.5
Class II	\$20,000 to \$39,999	6.0
Class III	\$10,000 to \$19,999	7.0
Class IV	\$ 5,000 to \$ 9,999	13.0
Class V	\$ 2,500 to \$ 4,999	23.0
Class VI	\$ 50 to \$ 2,499	50.5

WATERSHED PROBLEMS

Floodwater Damage

An analysis was made of storm events which occurred during a selected twenty-one year evaluation period. It was found that some flooding can be expected to occur on an average of 3.8 times per year. Floods large enough to cover fifty percent of the flood plain can be expected to occur about 40 times during a twenty-one year period.

Under present conditions a rain producing 1.0" of runoff will normally inundate 1,230 acres below the proposed structure sites.

The greatest inundation during the evaluation period occurred after the rain of Aug. 12, 1940 when 6.10 inches fell in a twelve hour period. The resulting runoff was estimated to be 4.83 inches, and the area inundated amounted to 2,034 acres. Of this, 1,618 acres were on the Three and Twenty Creek main and 416 acres were on tributaries.

Of the 2,034 acres of flood plain below structures, 235 are in low producing pasture. Most of the remaining flood plain has been utilized for the production of crops and pasture in the past. However, present flooding makes it uneconomical to improve and manage these areas for maximum production.

As a result of the frequent flooding, the fertile flood plain area has almost been abandoned. Crops have been moved to hill lands where flooding is avoided but erosion is being encouraged. Costs of production there are higher and yields are lower. In some cases, soils are being used beyond their capabilities. Farms cannot be managed to best advantage under these conditions.

Flood damage to roads and bridges in the watershed has been extensive in the past. Recent permanent concrete and pre-cast construction replacing temporary type bridges has greatly reduced flooding effects on bridges. Recent damages to abutments, fills and the remaining wood bridges is evidence that some danger still exists.

Fences are being damaged by direct water pressure against posts and by the impact of floating debris against the fence line.

Simpson Agricultural Experiment Station operated by Clemson College is located in the watershed. Some stream channel has been enlarged by them in an effort to protect flood plain where experiments extending over several years are planned. These attempts have not been successful and the protection afforded by this plan is being counted on by the Station Staff to give the required protection to these important and continuing studies.

The average annual floodwater damage under present conditions is estimated to be \$41,259. This includes \$1,815 road, bridge and fence damage and \$334 indirect damage (Table 5).

Sediment Damage

Deposition of sediment has not posed serious problems although some such

deposition does occur. Filling of ditches, channels and reservoirs are the most noteworthy affects. Sediment damages were not evaluated separately in this plan.

Erosion Damage

In general, the type of cover on the flood plain provides some protection against scour. Upland erosion is generally moderate but is severe in some areas. Steep slopes are eroding rapidly where the vegetation has been disturbed by man. These areas are in need of additional cover to prevent further damage. Some roadbanks and ditches are subject to rapid rates of erosion and are in need of some form of control.

Problems Relating to Water Management

The existing channel has adequate depth and capacity in most reaches to meet the drainage needs of those isolated areas in the flood plain which need drainage. The correction of the floodwater problem and restoration of the original channel capacity will correct the present need for drainage outlets.

The only water contamination noted in the watershed is from the Town of LaFrance. Since this discharge point is near the lower boundary of the watershed and is below all planned works of improvement, its effect on the watershed is considered as negligible.

PROJECTS OF OTHER AGENCIES

The South Carolina Commission of Forestry, in cooperation with the U. S. Forest Service, provides forest fire prevention, suppression, and forest management assistance for the private landowners in the Watershed. These services are furnished through Section 2 of the Clark-McNary Act and the Cooperative Forest Management Act.

The Three and Twenty Creek Watershed is located in the Anderson County and Pickens Soil Conservation Districts. These Districts have assisted 204 landowners (in the watershed) develop complete soil and water conservation plans for their farms. Thirty-six of the farms have all of the planned land

treatment measures installed on the ground.

The Hartwell Dam, constructed by the U. S. Army Engineers, is located about sixteen miles below the watershed. It is apparent that this existing reservoir will in no way affect the watershed. However, the watershed will affect it. Quantities of sediment now moving down Three and Twenty Creek and on into the large reservoir will be largely controlled by the seven proposed floodwater retarding structures.

BASIS FOR PROJECT FORMULATION

Examination of the watershed revealed that agricultural use of the flood plain at present is largely limited to native pasture and woodland. Small areas of the upper reaches are being planted to corn. The landowners desire to establish improved pasture and/or plant corn on both the land now used for unimproved pasture and the land that once was in production but is now in brush and woods. This is not feasible at present because of the flood hazard.

Project objectives proposed by the local sponsoring organizations include: (1) the protection of at least fifty percent of the flood plain against flooding to permit the growing of corn, truck crops, experimental crops and high-producing pasture, (2) treatment of critical areas and (3) application of the necessary land treatment.

Runoff characteristics and channel conditions were studied to determine control requirements. Highways and roads created the usual problems in establishing structure sites. Twenty-four structure sites, in various combinations and channel improvement were evaluated. The recommended system proved to be the most feasible. Analysis of physical and economic factors indicated that the desired levels of protection for growing corn, truck crops, experimental crops and high-producing pasture can be provided on 2,034 of the 3,122 acres of flood plain. The remaining 35 percent is either above planned structures, where it is not normally subjected to damaging floods or is on unprotected tributaries.

WORKS OF IMPROVEMENT TO BE INSTALLEDLand Treatment Measures

Land treatment measures were the basic element in formulating the project. All planned land use is within capabilities and the planned treatment is in accordance with the needs of the land for sustained agricultural use. These measures must be installed and properly maintained if the project is to function as planned. Estimated acreages of each general land use to be treated, with accompanying costs are shown in Table 1. The estimated installation cost is \$500,430.

Hayland plantings will be established on suitable upland and flood plain areas. This will increase infiltration rates, reduce runoff, and reduce sheet erosion on the upland areas. In the flood plain, it will provide benefits which were used in the justification of the structural measures planned for installation under the Act. Pasture will be established on idle land and on upland crop land which should have a perennial cover for soil protection and for sustained agricultural production. Trees will be planted on similar land which is more suitable for tree production. These land use adjustments will reduce runoff and erosion from the affected areas and will protect them from being destroyed for future agricultural use.

Vegetation which produces wildlife food and cover will be planted on odd areas which include power and telephone line rights-of-way, road borders, field corners, and suitable gullied areas. These plantings will improve wildlife habitat, reduce erosion, and make effective use of areas not suitable for other uses.

Stock-watering ponds will be located so as to facilitate more uniform distribution of grazing and permit management which will provide the most effective grass cover for control of runoff and sediment.

Terraces, diversions, and grassed waterways will be installed to control

runoff and sheet erosion and to provide adequate water disposal systems for the cultivated uplands.

Surface field ditches will provide an adequate disposal for excess surface water from some areas in the flood plain. These will be necessary to assure the full realization of benefits made possible by the reduction of flooding.

Land treatment measures considered necessary for proper functioning of structural measures will include 1,673 acres of critical area plantings and 45 miles (113 acres) of roadside erosion control. These measures are planned primarily for the control of erosion and a subsequent decrease in the amount of sediment delivered to the streams. Critical area plantings will consist of 523 acres of grasses and legumes, and 1,150 acres of trees. Vegetative control of areas now eroding along roads will result in a decrease in the amount of sediment delivered to the streams.

Structural Measures

Structural measures will include seven floodwater retarding structures and 105,690 lineal feet of channel improvement for flood prevention. This system of structural measures will provide the most feasible means of approaching the project objectives. Locations of these measures are shown on the project map in the back of this work plan. The estimated total installation cost of these measures is \$1,012,732, see Table 2. Channel improvement is estimated to cost \$383,712 and the floodwater retarding structures \$629,020. A typical floodwater retarding structure consists of an earth fill embankment with a fixed draw-down tube and a vegetated emergency spillway (Figure 2). Suitable vegetation will be established on embankments, emergency spillways, and borrow areas.

The combined drainage area above the seven floodwater retarding structures amounts to 25,706 acres, which is about 54 percent of the watershed. Total floodwater retention capacity will be 7,722 acre feet,

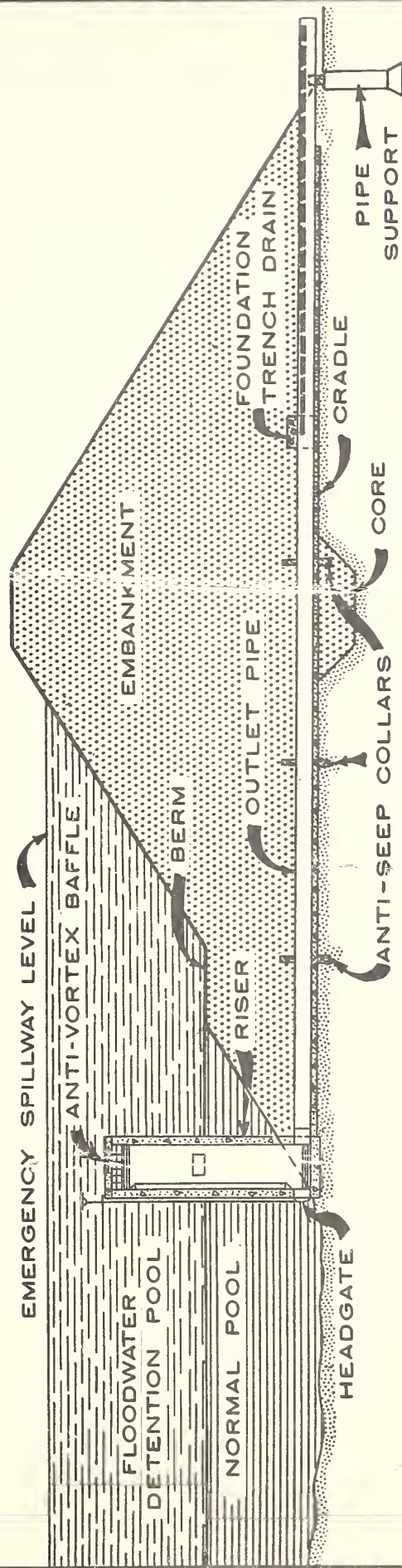


FIGURE 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

(TWO STAGE DROP INLET)

which is the equivalent of 3.61 inches of runoff from the drainage areas above dams, or 1.95 inches of runoff from the entire watershed.

Spoil from excavation of channels will be spread on either side of the stream to depths not exceeding three feet. No berm will be left and the entire spoil area will be shaped so as to facilitate planting and mowing. Openings will be left at all low places and pipe will be installed at the expense of landowners where roads on spoil banks are desired. All spoil banks will be planted to suitable vegetation. Channel designs are based on a five year annual peak for experimental and truck crops, and a three year annual peak for corn and improved pasture. This amounts to 2.4 to 1.8 inches of runoff in a twelve hour period.

Physical details of structural measures are shown in Tables 3 and 3A. Cost data are shown in Tables 1 and 2.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures are estimated to cost \$500,430. The PL 566 part of this cost includes the Federal share of critical area plantings, the estimated cost of technical assistance for Forest Service work, and five additional man years of Soil Conservation Service technical assistance to accelerate the planning and application of land treatment measures in the watershed. It is estimated that \$4,420 is now being spent annually for technical assistance in the watershed area by the Soil Conservation Service.

The cost of land treatment measures is based on average figures now being used in Anderson and Pickens Counties, and includes all costs for labor, machinery, seed, fertilizer, lime, etc.

Critical area treatment cost sharing is based on the Agricultural Conservation Program participation for similar practices. This amounts to a Federal contribution of fifty percent of costs of roadside erosion

control work and of grasses and legumes on critical areas, and seventy percent of the cost of planting trees on similar areas.

The installation costs shown in Tables 1 and 2 are based on the best information obtainable but must be considered as approximate. The engineering estimate is based on bid figures from recent lettings for similar structural measures. The construction cost estimate includes a twelve percent contingency figure to cover the various cost items which cannot be definitely predicted. Installation services include the cost of engineering, supervision, and administration needed to install the structural works of improvement. These figures are estimated on the basis of past experience.

The cost of administration of contracts and the value of easements and rights-of-way are listed under other funds. The cost of the administration of contracts is an estimated figure including fiscal, clerical and legal items as well as office supplies required for advertising for bids and letting contracts.

The values of land for easements were furnished by the local sponsoring organizations. These figures are \$130 per acre for upland; \$100 per acre for flood plain not swamped, and \$30 per acre for swampland. The estimated value of land, easements, and rights-of-way for structural measures is \$181,503. This includes the cost of moving fixed improvements.

In the operations stage, damsites will be investigated with drilling equipment and soil samples will be laboratory tested to more completely analyze conditions and furnish a better basis for final design.

Expected expenditures in accordance with the anticipated schedule of operations are as follows:

<u>Year</u>	<u>PL 566</u>	<u>Other</u>	<u>Total</u>
First	\$105,516	\$ 51,644	\$ 157,160
Second	88,161	98,904	187,065
Third	155,094	121,289	276,383
Fourth	237,874	192,215	430,089
Fifth	<u>387,805</u>	<u>74,660</u>	<u>462,465</u>
Total	\$974,450	\$538,712	\$1,513,162

EFFECTS OF WORKS OF IMPROVEMENT

It is the desire of the sponsors to have flood protection on fifty percent of the flood plain in the watershed for the production of corn, truck crops, experimental crops and improved pasture.

The effects of the proposed project were determined to be as follows:

(a) Of the average number of floods in a representative twenty-one year period, 72 will be reduced in magnitude sufficiently that they will cause no damage, and (b) 34 major floods in the series will be eliminated or reduced to minor floods. A rain causing one inch of runoff will inundate 1,230 acres below the proposed structures under present conditions. After project installation, one inch of runoff will not cause flooding below structures. For this analysis, floods which inundated more than fifty percent of the flood plain were considered to be major floods. The average annual number of floods in Reach IV, extending from Dam Number 12B to the confluence of Double Branch with the main stream, will be reduced from 5.7 to 0.38. In reach V, extending from Dams 14 and 15 to the spillway elevation of Dam Number 12B, the average number of floods per year will be reduced from 3.0 to 0.24. Flooding in other reaches below dams will be reduced similarly.

This reduction of flooding will enable landowners and operators to establish, manage and maintain 749 acres of high-producing pasture, 682 acres of corn, and 67 acres of truck and experimental (Horticultural) crops. All of the experimental crops and part of the truck crops will be grown on the Simpson Experiment Station farm which is operated by Clemson College. This change will include the restoration of 1,263 acres to a level of former productivity and 235 to a more intensive use.

The establishment of high-producing pasture and corn on the flood plain will permit the planting of 2,460 acres of upland to grassland or trees. This land, now unsuited for present uses, will have an improved cover that will reduce erosion and runoff.

Other planned land use adjustments are as follows:

1,513 acres of cultivated and idle to improved pasture.

1,263 acres of brush and low-producing woodland to crops and pasture.

Estimated land use after project is put into effect is: Cultivated 6,347 acres, Pasture 15,720 acres, Woodland 23,238 acres, and Miscellaneous 2,285.

The structural measures will directly benefit 2,034 acres of flood plain owned by one hundred and eighty three farmers. This includes one hundred acres below the lower watershed boundary. Flood damage to agricultural lands will be reduced from \$39,110 annually to \$636.

It is estimated that flood damages to roads and bridges in the amount of \$300 annually will be eliminated.

The principal road and bridge damage now occurring is to abutments and fills caused by high stages and occasional overtopping. This damage will be eliminated by reductions in stage.

Damages to fences will be reduced by reductions in amount and extent of flooding.

The sediment reducing effects of the planned works of improvement will result in a substantial reduction of silt moving toward the lower end of

the watershed. This will result in a very material benefit to the small reservoir operated by the LaFrance Industries and to the Hartwell reservoir operated by the U. S. Army Engineers. No monetary estimates were made on this protection but it is considered to be worthy of mention.

The 1959 U. S. Census of Agriculture, adjusted to the watershed, shows that a high percent of the farms had total sales of less than \$2,500. The effects of the project on these farms will be significant. The project will permit farm operators to make changes in land use that will be more in line with capabilities and needs of the land. Farmers' incomes will be improved from project benefits by a reduction of flood damage, a reduction of production costs, and by more intensive use of the flood plain. Dairy farmers indicated that they could harvest two crops per year from the flood plain with flood protection; thus increasing farm efficiency and permitting better farm management.

Landowners are planning to make the sediment pools and surrounding areas at structure sites available to the general public or organized groups for fishing, swimming, boating, water-skiing, picnicking and camping.

Since more than 75,000 people reside within a ten mile distance of the watershed, considerable use of the available incidental recreation potential is anticipated. About 75 annual user days per acre of sediment pool surface area will net 22,500 visitor days for the total water surface area of three hundred acres. In addition to supplying needed recreation, the user fees will help to bolster the economy of the watershed area.

In addition to increasing economic opportunities for low-income families the project is expected to have a favorable influence on the economy of the local community. These secondary benefits accrue as a result of increased income from transporting, processing and marketing of these goods and services that produce the primary project benefits, and from supplying additional materials to farmers.

PROJECT BENEFITS

The estimated floodwater damage reduction benefits from the installation of structural measures will be \$40,294. (Table 6) This includes \$37,588 of restoration benefits and \$254 of indirect benefits. It is estimated that land treatment measures will provide flood damage reduction benefits of \$87 annually. The total annual damage will be reduced from \$41,259 to \$878. (Table 5) Other flood prevention benefits listed in Table 6 are \$7,023 from more intensive land use.

It is estimated that the structures will provide incidental benefits from recreational use of \$16,280 annually. (Table 6) They are based on the value of a visitor-day of use and the estimated number of days of use annually. Access to reservoir areas will be made available to the general public or organized groups for their use for recreational purposes.

The value of local secondary benefits amount to \$15,286 annually. (Table 6) They accrue as a result of increased income from: (1) Transporting, processing and marketing of those goods and services that produce the primary project benefits. (2) The supplying of additional materials and services required to make possible the increased net returns which stem from installation of the project facilities. Secondary benefits from a National viewpoint were not considered pertinent to the economic evaluation.

COMPARISON OF BENEFITS AND COST

Average annual costs of structural measures will be \$45,478 and average annual benefits will be \$78,883. The benefit-cost ratio will be 1.7 to 1.0. This includes local secondary benefits of \$15,286 annually. (Table 6)

The benefit-cost ratio without the inclusion of local secondary benefits would be 1.4 to 1.0.

PROJECT INSTALLATION

Land Treatment Measures

The land treatment measures will be installed during the five-year installation period. Ten percent of the conservation practices will be installed during the first year, Twenty-five percent per year during the second through the fourth year, and the remaining fifteen percent during the fifth year.

The 1,673 acres of critical area plantings are planned to be installed during the five year installation period as follows: ten percent during the first year, twenty-five percent during each of the second and third years and twenty percent during each the fourth and fifth years. The roadside erosion control work is planned for the last four years as follows: thirty percent during each of the second through the fourth years, and ten percent in the fifth year.

The South Carolina State Forestry Commission, in cooperation with the U. S. Forest Service, will provide technical supervision for installing the forestry measures. These services will be furnished through the Three and Twenty Creek Watershed Conservation District. Cost-sharing assistance will be provided for all critical area plantings and for roadside erosion control work.

Technical assistance for establishing conservation measures, roadside erosion control, and the planting of grasses and legumes on critical areas will be furnished by the Soil Conservation Service.

All land treatment measures, except those specifically discussed in succeeding paragraphs, will be planned and applied by landowners and

operators in cooperation with the Anderson County and Pickens Soil Conservation Districts. The Soil Conservation Service will provide about five man-years of additional technical assistance to accelerate the planning and application of these measures. The landowners and operators will install all measures of this type at their own expense utilizing such assistance as may be available through the Agricultural Conservation Program.

Critical area treatment will include planting of 1,673 acres of gullied or seriously eroding land and 113 acres (45 miles) of roadside erosion control. The latter will be limited to badly eroding road banks, ditches and fills.

Cost sharing for tree plantings on critical areas will be formulated by the South Carolina Forestry Commission in cooperation with the U. S. Forest Service. The farmer will be expected to pay for the tree seedlings, furnish available mulch materials, furnish some labor for planting assistance, protect heeled-in tree seedlings, and relocate fences where necessary to protect planted areas from grazing. The Three and Twenty Creek Watershed Conservation District will contract with the South Carolina Forestry Commission for delivery of trees to the farm, to perform necessary site preparation, to furnish and plant grass seed when needed as part of site preparation, and to plant the trees. This has been determined to be seventy percent of the cost which is the portion figured to be paid for from PL 566 funds. The remaining thirty percent will be furnished in cash, kind, or a combination of the two by the landowners. Eleven hundred and fifty acres of critically eroding lands are designated for tree planting. Loblolly pine is recommended for this type planting.

The South Carolina Commission of Forestry, in cooperation with the U. S. Forest Service, will assign a watershed forester to this project for eighteen months.

He will provide private landowners technical assistance on planned forestry measures. The present cooperative Forest Management program will also continue throughout the installation period.

Grasses and legumes will be planted on 523 acres of critical areas at an estimated cost of \$41,840. The sponsors will be responsible for furnishing labor and equipment for preparing seedbed, applying fertilizer, planting seed and cultipacking after seeding, which has been determined to be fifty percent of the cost. Arrangements for landowners to accomplish this work will be made in Farmer-District Cooperative agreements between the Anderson County or the Pickens Soil Conservation District and the landowners concerned. The remaining fifty percent of the cost will be provided by the Service from PL 566 funds through project agreements with the sponsors and will include actual cost of necessary seed, fertilizer, lime, and mulch material delivered to the job.

Erosion control work will be accomplished on forty-five miles (113 acres) of roadside at an estimated cost of \$28,250. The sponsors will contribute fifty percent of the cost by furnishing labor and equipment for necessary sloping of roadbanks, moving fences where necessary, preparing seedbeds, applying fertilizer and planting seed. Sloping of roadbanks will be accomplished with assistance from the Anderson County Road Supervisor and the South Carolina Highway Department. The landowners part of this work will be arranged for in Farmer-District cooperative agreements as described above under grass and legume planting of critical areas. The remaining fifty percent of the cost will be provided by the

Service from PL 566 funds through project agreements with the local sponsoring organizations and will include actual cost of seed, fertilizer and mulch materials delivered to the job.

Structural Measures

The Anderson County and the Pickens Soil Conservation Districts will obtain agreements to carry out recommended soil conservation measures and proper farm plans from owners of not less than 50 percent of the lands situated in the drainage area above each retention reservoir to be installed with Federal assistance. These agreements will be obtained prior to any PL 566 funds being provided for the construction of these structures.

As a condition and prior to providing financial assistance for the construction of any planned structural measures, at least 75 percent of the effective land treatment measures must be installed, or their installation commenced, on those sediment source areas which, if uncontrolled, would require a material increase in the cost of construction, operation or maintenance of the structural works of improvement.

Structural measures will consist of seven floodwater retarding structures and 105,690 lineal feet of channel improvement. These measures will be installed under contracts administered by the Three and Twenty Creek Watershed Conservation District. This organization will assume responsibility for legal and stenographic services, administration of contracts, and obtaining the necessary land, easements, and rights-of-way for all structural measures. The estimated value of land, easements, and rights-of-way is \$181,503.

To facilitate the installation of the structural measures, three construction units have been designated. Unit number 1 includes structure number 8B and associated channel improvement on Cuffie Creek. Unit number 2 includes structure number 9B and associated channel improvement on Big

Garvin Creek. Construction unit number 3 includes structures number 14 and 15 and associated channel improvement on Pickens Creek. Construction units number 1 and 2 are scheduled to be installed the first year. Unit number 3 is scheduled for construction in the third year. All other structural measures are dependent on these three construction units and their installation must be concurrent with or after the installation of units numbered 1, 2, and 3. The necessary land easements and rights-of-way for all structural measures in each construction unit will be obtained before commencing construction in that unit.

A typical floodwater retarding structure plan is shown on the following page.

An Act creating the Three and Twenty Creek Watershed Conservation District was passed on October 3, 1961 with 83 percent of the voters being in favor of the creation. The District has limited taxing powers and the power of condemnation.

The Soil Conservation Service will provide installation services, including surveys, site investigations, designs, preparation of specifications, inspection of construction, and other services.

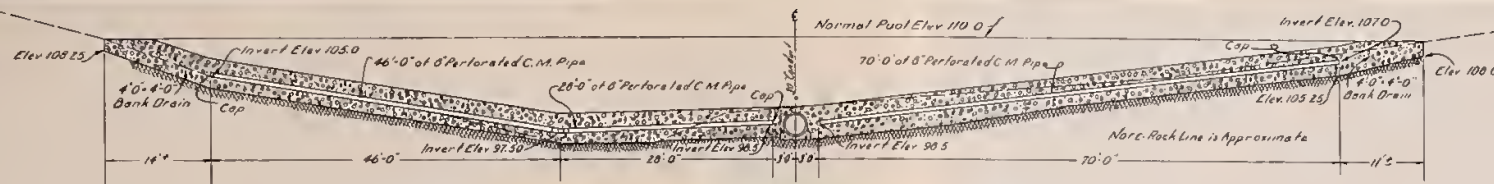
FINANCING PROJECT INSTALLATION

It is planned that land treatment measures which are normally included in conservation farm plans will be financed by individual landowners utilizing such assistance as may be available through the Agricultural Conservation Program.

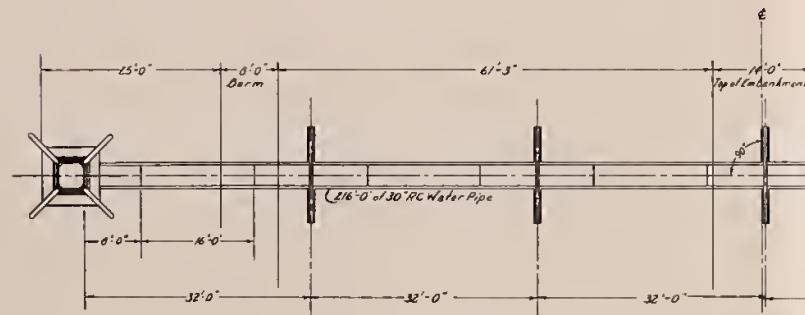
Landowners are expected to furnish some materials, labor and equipment to install critical area plantings. In so doing, they will meet the sponsoring local organizations obligation for cost sharing.

It is anticipated that all easements and rights-of-way will be donated.

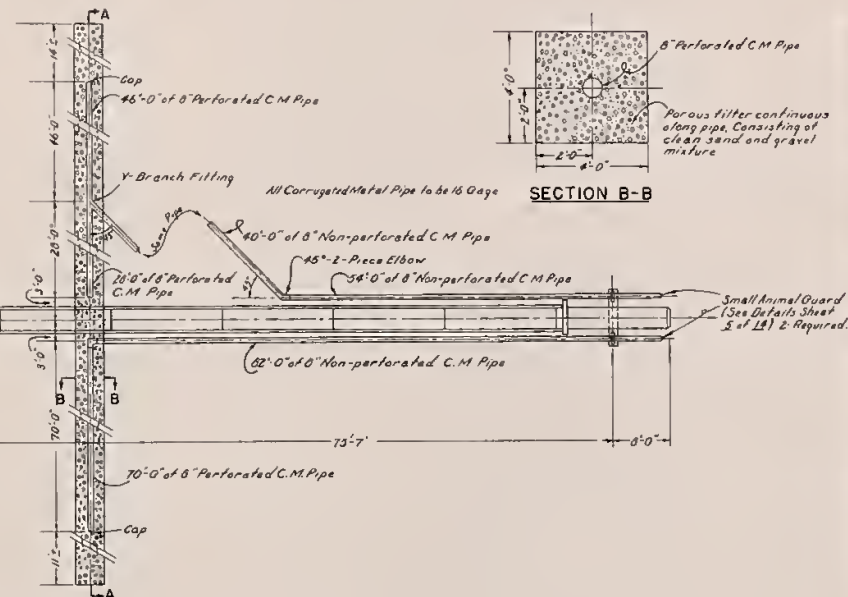
The Three and Twenty Creek Watershed Conservation District will ob-



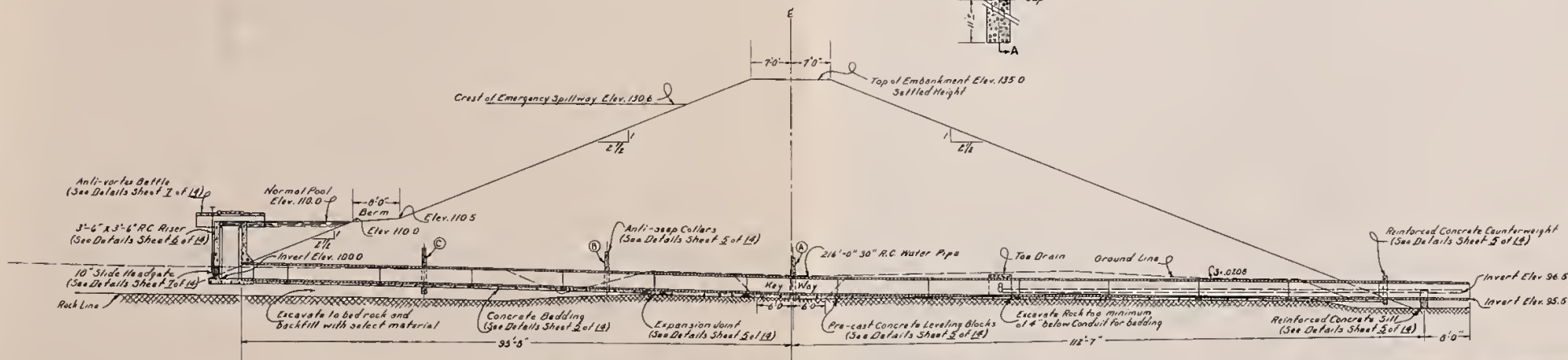
SECTION A-A
ELEVATION ALONG CENTERLINE OF 8" PERFORATED C.M. PIPE



PLAN



SECTION B-B



SECTION ALONG CENTERLINE OF 30" REINFORCED CONCRETE PIPE
STA. 4+33 CENTERLINE OF DAM

PLAN
TYPICAL FLOODWATER
RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By
Drawn		Title
Traced		Title
Checked		Sheet
		Drawing No.
		No.
		of

tain funds for carrying out its obligations from a tax levy on the real property within the District.

The cost of installing the forestry measures is estimated to be \$108,520. of which \$57,975 will be PL 566 funds and \$50,545 will be other funds. The land treatment measures, excluding critical area tree planting, will cost \$26,550. This will be other than PL 566 funds. Critical area tree planting will cost \$60,150, of which \$42,105 will be PL 566 funds and \$18,045 will be other funds. The other funds for land treatment will be provided by the landowners. It is expected that Agricultural Conservation Program cost-sharing will be available to qualified landowners for installing the forestry measures.

The cost of technical assistance is estimated to be \$21,820. This consists of \$15,870 of PL 566 funds, \$5,540 to be provided by the South Carolina Commission of Forestry as matching funds, and \$410 to be provided by the South Carolina Commission of Forestry in cooperation with the U. S. Forest Service through the going Cooperative Forest Management funds. The State will begin cooperation with its funds at the earliest feasible date. However, if it does not have funds available for cost-sharing during the first year of installation, the forestry technical assistance during this period will be financed wholly from PL 566 funds.

Federal assistance for carrying out the works of improvement, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (PL 566, 83rd Congress, 68 Stat. 666) as amended. Financial and other assistance to be furnished by the Soil Conservation Service and the U. S. Forest Service in carrying out the project will contingent on the appropriation of funds for this purpose.

PROVISIONS FOR OPERATION AND MAINTENANCE

The responsibility for all necessary maintenance on land treatment measures will be assumed by the Anderson County and the Pickens Soil Conservation Districts in their respective areas. Their plans for

accomplishing this maintenance is given in the succeeding paragraphs.

Land treatment measures normally included in conservation farm plans will be maintained by farmers on whose lands they are located in accordance with the provisions of their conservation farm plans with the Anderson County and the Pickens Soil Conservation Districts.

Land treatment measures to be maintained on critical areas include 523 acres of grasses and legumes and 113 acres (45 miles) of roadside erosion control. The 1,150 acres of trees included under this heading are to be protected from fire and grazing.

Critical area plantings will be maintained by the farmers on whose lands the plantings are located. The cost of this maintenance will be borne by the individual farmers. Maintenance requirements will be included in the conservation farm plans or by amendments thereto.

The Three and Twenty Creek Watershed Conservation District will assume the over-all responsibility for maintaining all roadside erosion control work. Individual landowners, cooperating with the Soil Conservation Districts, are expected to assist with this maintenance.

Structural measures to be maintained will consist of seven floodwater retarding structures, and 105,690 lineal feet of channel improvement. The responsibility for the maintenance of all structural measures to be constructed in the watershed will be assumed by the Three and Twenty Creek Watershed Conservation District. Their plan for accomplishing this maintenance follows:

Minor or routine maintenance such as removing debris, performing chemical control to suppress undesirable vegetation, and mowing or fertilizing grass will be performed by farmers on whose lands the improvements are located. This maintenance will be written in the conservation farm plans or in amendments thereto. Major maintenance such as removing sand bars from channels

and repairing unusual damages to emergency spillways or stream banks will be performed by the Three and Twenty Creek Watershed Conservation District with funds realized from a tax levy on real property or from other sources. Specific maintenance agreements will be executed prior to the issuance of Invitation to bid.

The estimated annual cost of operation and maintenance of all structural measures is \$13,425 (Table 4).

Joint inspection by the Soil Conservation Service and local representatives of each of the structural measures will be performed at least once every year or after each major storm, whichever is more often. The Three and Twenty Creek Watershed Conservation District will maintain a record of operation and maintenance inspections in their files. These reports will be made available to interested persons upon request. The Soil Conservation Service representative designated to make inspections will prepare a written narrative setting forth his findings.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Three and Twenty Creek Watershed, South Carolina

Installation Cost Item (1)	Unit (2)	Number Non-Fed. Land (3)	Estimated Cost (Dollars) 1/			Total (6)
			PI-566 Funds		Other Non-Fed. Land (5)	
			Non-Fed. Land (4)			
<u>LAND TREATMENT</u>						
Soil Conservation Service						
Cropland	Ac.	6,300		130,019		130,019
Grassland	Ac.	2,300		115,500		115,500
Critical Area Plantings	Ac.	523	20,920	20,920		41,840
Roadside Erosion Control	Ac.	113	14,125	14,125		28,250
Technical Assistance			54,201	22,100		76,301
SCS - Subtotal			89,246	302,664		391,910
Forest Service						
Woodland	Ac.	23,238		26,550		26,550
Tree Planting, Critical	Ac.	1,150	42,105	18,045		60,150
Technical Assistance			15,870	5,950		21,820
FS - Subtotal			57,975	50,545		108,520
TOTAL LAND TREATMENT			147,221	353,209		500,430

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST (CON'T.)

Three and Twenty Creek Watershed, South Carolina

Installation Cost Item (1)	Unit (2)	Number Non-Fed. Land (3)	Estimated Cost (Dollars) 1/			Total (6)
			PL 566 Funds		Other Non-Fed. Land (5)	
			Non-Fed. Land (4)			
STRUCTURAL MEASURES						
Soil Conservation Service Floodwater Ret. Structures Channel Improvement SCS Sub-total	No. L. Ft.	7 105,690	366,010 284,088 650,098			366,010 284,088 650,098
Sub-Total - Construction			650,098			650,098
Installation Services						
Soil Conservation Service Engineering Services Other SCS Sub-total			112,326 64,805 177,131			112,326 64,805 177,131
Subtotal - Installation Services			177,131			177,131
Other Costs						
Land, Easements & R/W Administration of Contracts				181,503 4,000		181,503 4,000
Subtotal - Other				185,503		185,503
TOTAL STRUCTURAL MEASURES			827,229	185,503		1,012,732
TOTAL PROJECT			974,450	538,712		1,513,162
SUMMARY						
Subtotal SCS			916,475	488,167		1,404,642
Subtotal FS			57,975	50,545		108,520
TOTAL PROJECT			974,450	538,712		1,513,162

1/ Price base 1962.

Date Aug. 1963

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of Work Plan Preparation)

Three and Twenty Creek Watershed, South Carolina

Measures (1)	Unit (2)	Applied to date (3)	Total Cost (Dollars) 1/ (4)
<u>LAND TREATMENT</u>			
Conservation Cropping Systems	Ac.	2,965	\$ 2,965
Hayland Planting	Ac.	1,120	38,360
Pasture Planting	Ac.	7,534	338,800
Wildlife Habitat Development	Ac.	30	900
Farm Ponds	No.	45	31,500
Terraces, Gradient	Ft.	4,118,400	43,243
Terraces, Parallel	Ft.	87,120	1,307
Grassed Waterways	Ac.	410	18,450
Drainage, Mains and Laterals	Ft.	12,100	3,600
Tile Drain	Ft.	14,500	3,190
Tree Planting	Ac.	897	17,940
Critical Area Planting			
Grasses and Legumes	Ac.	50	2,125
Tree Planting	Ac.	115	3,680
Roadside Erosion Control	Mi.	12	5,400
TOTAL	xxx	xxx	\$511,460

Date Aug. 1963

1/ Price base - 1962

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Three and Twenty Creek Watershed, South Carolina
(Dollars) 1/

Structure Site No. or Name	Installation Cost-P.L. 566 Funds				Installation Cost - Other Funds					
	Con- struction	Instal. Services		Total P. L. 566	Con- struction	Instal- lation Services	Other		Total Other	Total Inst. Cost
		Engin- eering	Other				Adm. of Con- tracts	Ease- ments & R/W		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
FWRS No. 5B	48,160	8,600	4,825	61,585	-	-	300	9,615	9,915	71,500
" " 6A	39,609	7,073	3,968	50,650	-	-	300	9,596 ^{2/}	9,896	60,546
" " 8B	31,083	6,938	3,232	41,253	-	-	300	6,845	7,145	48,398
" " 9B	39,847	7,115	3,992	50,954	-	-	300	10,290 ^{3/}	10,590	61,544
" " 12B	115,360	15,450	11,118	141,928	-	-	300	94,941 ^{4/}	95,241	237,169
" " 14	54,869	9,798	5,496	70,163	-	-	300	10,376 ^{5/}	10,676	80,839 ^{12/}
" " 15	37,082	6,622	3,715	47,419	-	-	300	21,305 ^{6/}	21,605	69,024
Subtotal - Structures	366,010	61,596	36,346	463,952	-	-	2,100	162,968	165,068	629,020
Ch. Imp.-Excavation										
Main	175,840	31,400	17,615	224,855	-	-	700	12,610	13,310	238,165
Tributary (Below 5B)	2,800	500	280	3,580	-	-	100	130	230	3,810
Double Branch	3,360	600	337	4,297	-	-	100	300	400	4,697
Cuffie Creek	25,200	4,500	2,525	32,225	-	-	400	1,495	1,895	34,120
Pig Garvin	51,688	9,230	5,178	66,096	-	-	400	2,500	2,900	68,996
Pickens Creek	22,400	4,000	2,244	28,644	-	-	100	1,400	1,500	30,144
Tributary (Below 15)	2,800	500	280	3,580	-	-	100	100	200	3,780
Subtotal - Ch. Improvement	284,088	50,730	28,459	363,277	-	-	1,900	18,535	20,435	383,712
GRAND TOTAL	650,098	112,326	64,805	827,229	-	-	4,000	181,503	185,503	1,012,732

1/ Price base: 1962

2/ Includes \$3,081 for fixed improvements.

3/ Includes \$1,500 for fixed improvements.

4/ Includes \$11,481 for fixed improvements.

5/ Includes \$7,036 for fixed improvements.

6/ Includes \$13,850 for fixed improvements.

Date Aug. 1963

TABLE 3 - STRUCTURE DATA
FLOODWATER RETARDING STRUCTURES
Three and Twenty Creek Watershed, South Carolina

Item	Unit	Structure Number			
		5B	6A	8B	9B
Drainage Area	sq. mi.	3.77	2.73	2.83	3.63
Storage Capacity					
Sediment (Submerged)	ac. ft.	144	96	126	144
Sediment (Aerated)	ac. ft.	134	93	110	135
Floodwater	ac. ft.	790	492	482	632
Total	ac. ft.	1,068	681	718	911
Between high and low stages	ac. ft.	334	263	271	348
Surface Area					
Sediment pool	ac.	28	21	31	37
Floodwater pool	ac.	107	67	78	111
Volume of Fill	cu.yds.	57,100	52,000	26,000	36,000
Elevation Top of Dam	ft.	811.0	810.0	810.5	783.0
Maximum Height of Dam	ft.	33	35	24	23
Emergency Spillway					
Crest elevation	ft.	807.0	805.0	808.5	781.0
Bottom width	ft.	150	100	100	150
Type		veg	veg	veg	veg
Percent chance of use		2	4	4	4
Ave. Curve No. - Cond. II		68	69	69	69
Emergency spillway hydrograph					
Storm rainfall (6-hr.)	in.	8.8	6.0	6.0	6.0
Storm runoff	in.	4.9	2.7	2.7	2.7
Velocity of flow (v_c) $\frac{1}{2}$	ft./sec.	4.0	*	*	*
Discharge rate $\frac{1}{2}$	c.f.s.	325	*	*	*
Max. w.s. elev. $\frac{1}{2}$	ft.	807.7	*	*	*
Freeboard hydrograph					
Storm rainfall (6-hr.)	in.	15.0	15.0	8.8	8.8
Storm runoff	in.	10.5	10.7	5.0	5.0
Velocity of flow (v_c) $\frac{1}{2}$	ft./sec.	9.4	9.5	4.6	5.0
Discharge rate $\frac{1}{2}$	c.f.s.	3,680	3,220	750	645
Max. w.s. elev. $\frac{1}{2}$	ft.	811.0	809.9	810.4	792.9
Principal Spillway					
Capacity-low stage $\frac{2}{3}$	c.f.s.	30	22	23	29
Capacity-high stage $\frac{2}{3}$	c.f.s.	96	96	96	96
Capacity Equivalents					
Sediment volume	in.	1.38	1.30	1.56	1.44
Detention volume	in.	3.93	3.38	3.19	3.26
Spillway storage	in.	2.77	2.89	1.32	1.60
Class of Structure		b	a $\frac{2}{3}$	a	a

TABLE 3 - STRUCTURE DATA CONT.
FLOODWATER RETARDING STRUCTURES
Three and Twenty Creek Watershed, South Carolina

Item	Unit	Structure Number			Total
		12B	14	15	
Drainage Area	sq. mi.	22.86 ^{4/}	1.62	2.72	40.16
Storage Capacity					
Sediment (Submerged)	ac. ft.	730	83	134	1,457
Sediment (Aerated)	ac. ft.	736	65	99	1,372
Floodwater	ac. ft.	4,427	327	572	7,722
Total	ac. ft.	5,893	475	805	10,551
Between high and low stages	ac. ft.	2,255	165	258	3,894
Surface Area					
Sediment pool	ac.	139	14	30	300
Floodwater pool	ac.	530	38	84	1,015
Volume of Fill	cu. yds.	107,500	77,600	26,550	382,750
Elevation Top of Dam	ft.	814.5	875.5	856.5	xx
Maximum Height of Dam	ft.	43	33	27	xx
Emergency Spillway					
Crest elevation	ft.	804.5	872.0	853.0	xx
Bottom width	ft.	350	150	200	xx
Type		veg	veg	veg	xx
Percent chance of use		2	2	2	xx
Ave. Curve No. - Cond. II		70	71	70	xx
Emergency Spillway Hydrograph					
Storm rainfall (6-hr.)	in.	8.8	8.8	8.8	xx
Storm runoff	in.	4.6	5.3	5.2	xx
Velocity of flow (v_c) ^{1/}	ft./sec.	5.5	3.7	4.1	xx
Discharge rate ^{1/}	c.f.s.	2,100	400	450	xx
Max. w.s. elev. ^{1/}	ft.	805.9	872.9	853.9	xx
Freeboard hydrograph					
Storm rainfall (6-hr.)	in.	22.5	15.0	15.0	xx
Storm runoff	in.	16.3	11.0	10.9	xx
Velocity of flow (v_c) ^{1/}	ft./sec.	13.9	8.0	8.0	xx
Discharge rate ^{1/}	c.f.s.	32,800	2,555	3,360	xx
Max. w.s. elev. ^{1/}	ft.	814.2	875.4	856.3	xx
Principal Spillway					
Capacity-low stage ^{2/}	c.f.s.	183	13	22	xx
Capacity-high stage ^{2/}	c.f.s.	540	96	96	xx
Capacity Equivalents					
Sediment volume	in.	1.20	1.71	1.60	xx
Detention volume	in.	3.63	3.78	3.94	xx
Spillway storage	in.	5.89	1.90	2.55	xx
Class of Structure		b ^{3/}	b	b	xx

^{1/} Maximum during passage of hydrograph.

^{2/} The discharges are average.

^{3/} Criteria between class b and class c used for freeboard hydrograph.

^{4/} Structures 14 and 15 are in series with No. 12B. Total drainage area above No. 12B is 27.20 square miles.

^{5/} Class "b" criteria used for freeboard hydrograph.

* Flow through spillway was negligible.

Date Aug. 1963

TABLE 3A - STRUCTURE DATA

CHANNELS

Three and Twenty Creek Watershed, South Carolina

Channel Designation	Station Numbering for Reach		Water-shed Area (sq.mi.)	Required Channel Capacity (CFS)	Planned Channel Capacity		3/ Bottom Width (Ft.)	Depth (Ft.)	Slope (Ft./Ft.)	"N" Value	Vel. in Channel (Ft./Sec.)	Volume Exc. (Cu. Yd)
	Sta.	Sta.			2/ From Struc. (CFS)	Total (CFS)						
Main	0+00	20+00	0.2	420	218	462	20	5.0	.00135	.035	3.7	8,741
	20+00	62+02	1.8	590	248	620	24	5.4	.00135	.035	3.9	18,364
	62+02	88+69	2.2	620	248	620	24	5.4	.00135	.035	3.9	10,668
	88+69	127+03	2.5	655	248	663	26	5.4	.00135	.035	3.9	17,892
	127+03	143+93	3.8	740	248	764	30	5.4	.00135	.035	4.0	11,079
	143+93	161+93	4.0	740	248	764	30	5.4	.00135	.035	4.0	11,400
	161+93	179+93	5.6	940	270	1,096	35	5.8	.00104	.030	4.3	11,400
	179+93	208+21	6.5	1,100	270	1,170	40	5.8	.00104	.030	4.4	18,225
	208+21	245+21	9.0	1,190	270	1,328	45	5.8	.00104	.030	4.5	19,596
	245+21	303+21	11.2	1,250	270	1,328	45	5.8	.00104	.030	4.5	35,444
	303+21	361+56	13.2	1,640	270	1,680	50	6.0	.0012	.030	5.0	53,163
	361+56	400+73	17.5	1,850	270	1,830	55	6.0	.0012	.030	5.0	45,263
	400+73	435+73	18.3	1,890	293	1,830	55	6.0	.0012	.030	5.0	47,444
	435+73	457+40	19.8	1,950	293	1,980	60	6.0	.0012	.030	5.0	26,245
	457+40	485+40	20.2	1,980	293	1,980	60	6.0	.0012	.030	5.0	32,667
	485+40	502+07	26.6	2,310	322	2,325	70	6.0	.0012	.030	5.1	19,446
	502+07	524+87 1/2	27.1	2,340	322	1,350	70	5.0	.0007	.030	3.6	26,093
Big Garvin Creek	0+00	22+00	0.4	220	29	267	8	5.0	.0030	.040	4.1	5,622
	22+00	51+00	1.3	353	29	367	10	5.0	.0030	.035	4.9	7,089
	51+00	71+00	1.6	376	29	442	12	5.0	.0030	.035	5.2	2,593
	71+00	102+00	2.0	411	29	504	14	5.0	.0030	.035	5.3	13,434
	102+00	130+34	5.7	894	29	918	24	6.0	.0021	.035	5.1	16,373
	130+34	151+68	5.9	934	29	998	26	6.0	.0021	.035	5.2	16,992
	151+68	163+35	6.0	940	29	998	26	6.0	.0021	.035	5.2	8,861

TABLE 3A - STRUCTURE DATA (Con't.)

CHANNELS

Three and Twenty Creek Watershed, South Carolina

Channel Designation	Station Numbering for Reach		Water-shed Area (sq.mi)	Required Channel Capacity (CFS)	Planned Channel Capacity		3/ Bottom Width (Ft.)	Depth (Ft.)	Slope (Ft./Ft.)	"N" Value	Vel. in Channel (Ft./Sec.)	Volume Exc. (Cu.Yd)
	Sta.	Sta.			2/ From Struc. (CFS)	Total (CFS)						
Pickens Creek	0+00	17+30	0.2	78	13	115	3	4.6	.0036	.045	3.3	1,730
	17+30	38+14	1.1	100	13	136	3	5.0	.0036	.045	3.4	1,931
	38+14	59+50	1.7	308	35	322	9	5.0	.0036	.040	4.6	4,984
	59+50	84+50	2.3	385	35	426	12	5.6	.0026	.040	4.3	3,981
	84+50	114+50	2.9	537	35	561	14	5.6	.0026	.035	5.1	2,768
Tributary to Pickens Creek	114+50	124+50	3.0	537	35	561	14	5.6	.0026	.035	5.1	1,852
	0+00	13+33	0.3	65	22	124	3	5.0	.0029	.045	3.1	1,629
Tributary (below 5B)	0+00	8+00	0.1	80	30	115	3	4.0	.0046	.045	3.6	533
	8+00	11+33	0.2	100	30	156	3	5.0	.0046	.045	3.9	222
	11+33	19+33	0.3	100	30	156	3	5.0	.0046	.045	3.9	741
Cuffie Creek	0+00	12+67	0.2	75	23	144	3	5.0	.0040	.045	3.6	2,206
	12+67	37+17	0.8	158	23	194	4	5.0	.0040	.040	4.3	5,263
	37+17	62+18	1.5	250	23	282	7	5.0	.0040	.040	4.7	2,872
	62+18	87+18	1.8	280	23	308	10	5.0	.0030	.040	4.1	648
	87+18	119+85	2.3	330	23	382	12	5.0	.0030	.040	4.5	3,000
	119+85	153+20	2.7	365	23	437	14	5.0	.0030	.040	4.6	6,176
	153+20	166+53	3.2	410	23	437	14	5.0	.0030	.040	4.6	3,802
	166+53	184+87	3.3	425	23	437	14	5.0	.0030	.040	4.6	6,113
Double Branch	45+60	69+75	0.3	225	22	235	5	5.0	.0046	.040	4.7	2,415
	69+75	72+25	1.4	225	22	235	5	5.0	.0046	.040	4.7	463

1/ Outlet on rock shoal, channel capacity is reduced.

2/ Average release rate low stage.

2/ All channels have 1:1 side slopes.

Date

Aug. 1963

TABLE 4 - ANNUAL COST

Three and Twenty Creek Watershed, South Carolina
(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost <u>2/</u>	Operation and Maintenance Cost <u>3/</u>	Total
(1)	(2)	(3)	(4)
<u>STRUCTURAL MEASURES</u> Floodwater retard- ing structures No. 5B, 6A, 8B, 9B, 12B, 14, 15, and associated Channel Improvement	32,053	13,425	45,478
Total	32,053	13,425	45,478

1/ Price base: Installation Cost - 1962.

2/ Amortized at 3 percent interest rate for 100 years

3/ Long-term prices.

Date Aug. 1963

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Three and Twenty Creek Watershed, South Carolina
(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
(1)	(2)	(3)	(4)
Floodwater			
Crop and Pasture	39,110	636	38,474
Other Agricultural (Fence)	1,515	162	1,353
Nonagricultural (Roads & Bridges)	300	0	300
Subtotal	40,925	798	40,127
Indirect	334	80	254
Total	41,259	878	40,381

1/ Price base: Projected

Date Aug. 1963

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Three and Twenty Creek Watershed, South Carolina
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/					Avg. Annual Cost 3/	Benefit Cost Ratio
	Flood Prevention				Total		
	Damage Reduction	More Intensive Land Use	Incidental Recreation	Secondary			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Structural Measures							
Floodwater retarding structures No. 5B, 6A, 8B, 9B, 12B, 14 15, and related Channel Improvement	40,294	7,023	16,280	15,286	78,883	45,478	1.7 to 1.0
GRAND TOTAL	40,294 2/	7,023	16,280	15,286	78,883	45,478	1.7 to 1.0

^{1/} Price base: Long-term projected.

^{2/} In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$87 annually.

^{3/} See Table 4.

Date Aug. 1963

TABLE 7 - CONSTRUCTION UNITS

Three and Twenty Creek Watershed, South Carolina
(Dollars)

Measures in Construction Unit	Annual Benefit <u>1/</u>	Annual Cost <u>2/</u>
(1)	(2)	(3)
1. Floodwater retarding structure No. 8B and associated Channel Improvement on Cuffie Creek.	5,857	3,848
2. Floodwater retarding structure No. 9B and associated Channel Improvement on Big Garvin Creek.	11,163	6,462
3. Floodwater retarding structures No. 14 & 15, and associated Channel Improvement on Pickens Creek.	10,704	7,361

1/ Price base - Long-term projected.

2/ See Table 4.

Date Aug. 1963

INVESTIGATIONS AND ANALYSESGeologic

Examination of available maps, supplemented with reconnaissance of the area, provided a general knowledge of overall conditions. Soil and rock conditions in vicinities of proposed dams were observed more carefully in order to determine the physical feasibility of dam construction with regard to foundation conditions, possibility of rock excavation, and availability of construction material. Limited subsurface exploration with hand tools supplemented areal study. Channels were reconnoitered in areas of proposed enlargement to determine effects on excavation that might be caused by soil conditions or occurrence of rock.

These preliminary studies of prospective damsites indicated favorable geologic conditions for the installation of dams. Foundation conditions appear to be generally good, excessive amounts of rock excavation seem very unlikely, and earth materials with satisfactory engineering properties for construction occur in abundance.

Rock excavation in areas of channel excavation is not anticipated and soils should be relatively stable.

Sedimentation

Soil survey maps and field observations provided basic information used to compute rates of sediment production which were used to determine sediment storage requirements at reservoir sites. Sediment storage requirements were calculated on the basis of a one-hundred-year accumulation with wet storage occurring during the first fifty years only.

Occurrences of deposition, swamping, and scour were observed, but the nature of such occurrences is such that separate damage evaluation is not practicable. Damages resulting from these phenomena and benefits which might accrue as a result of a reduction are reflected in other damage and benefit evaluations.

Hydraulic and Hydrologic

Precipitation data of the Clemson, South Carolina rain gaging station, obtained from the U. S. Weather Bureau publication "Climatological Data," were used in the analysis. From a study of the annual rainfall records, the most representative period was determined to be 1935-1955 inclusive.

The weighted average curve number was determined by applying information obtained from local observation, the U. S. Forest Service, local Work Unit Conservationist and local Soil Scientist to the procedure outlined in NEH, Section 4, Supplement A. Runoff was determined by applying rainfall amounts to the weighted average curve number for this watershed.

The largest runoff-producing rain that occurred during the evaluation period produced 4.83 inches of runoff and resulted in the inundation of 2,034 acres of flood plain down stream from the proposed locations of structures. This includes 100 acres below lower boundary of watershed. The rain occurred August 12, 1940, when 6.10 inches of precipitation fell in a 12 hour period. This rain was used as a basis in making the hydraulic computations.

Data from field surveys were used to determine stage-discharge relationships at 16 valley cross-sections. Calculations were based on Manning's formula.

Design hydrographs for floodwater retarding structures were developed in accordance with procedures outlined in Section 3.21, NEH 4, Supplement A, Advisory Notice W-2018 and Engineering Memorandum EWP-5. All structures have two stage inlets and a low stage average release rate of 8 cfs. The storage between high and low stages complies with Watershed Memorandum EWP-5.

The Wilson method was used for the valley flood routing. A weighted average travel time was used in this procedure.

Runoff-acres flooded curves were developed for present and future conditions.

Runoff frequency lines were developed using the annual series method to determine the 33.3 and 20.0 percent chance of occurrence. Channel design was then accomplished by flood routing, as applicable, either the 3 year frequency storm of 1.85 inches runoff or the 5 year frequency storm of 2.40 inches runoff, 12 hour duration, through a tentative channel system.

Engineering

Temporary bench marks were established throughout the watershed and referenced to mean sea level. These bench marks were used for vertical control in surveying the channel and valley cross sections, and the topo maps of seven floodwater retarding structures.

Channel and valley cross sections were located on aerial photographs. Distances between cross sections were scaled from the aerial photographs. Profiles of the planned channels were plotted and Manning's formula was used for their design. This resulted in the channel system shown in table 3A and on the project map.

Topographic maps were made of the seven floodwater retarding structures with the plane table and telescopic alidade.

Floodwater retarding structures were designed in accordance with Engineering Memorandums SCS-27, EWP-5, Engineering and Watershed Planning Unit Memorandum Number 5, Supplement Number 1, and Engineering Memorandum SCS-31 revised. Flood routing through the reservoirs was accomplished in accordance with sections of the Engineering Handbook published by the Soil Conservation Service.

Forestry

A field survey determined the upland forest conditions. Systematic samples indicated ground cover, forest and hydrologic conditions, treatment needs and measures. Additional surveys and information gathered from

other agencies and forestry officials determined the amount of remedial measures. The installation period limits the work in the recommended program. These measures include only those that contribute directly to flood reduction and soil stabilization.

Fish and Wildlife

A study of fish and wildlife in the watershed and the effect of this project on it was made by the U. S. Fish and Wildlife Service.

Stream fishery habitat in the watershed is of negligible value. Rabbits, squirrels, quail and doves provide the major hunting opportunity.

The study concluded that the construction and operation of the project will not significantly affect fish and wildlife resources in the watershed. A further observation was that the improvement of fish and wildlife habitat depends largely upon the desire of the individual landowners and the effort expended in the application of suitable management measures. The South Carolina Wildlife Resources Department will furnish technical advice and planting materials to persons interested in such developments.

Economic

Methods used in making the economic investigations and analyses followed those approved by the Soil Conservation Service in benefit-cost evaluations on land and water resource projects. Basic data were obtained from local farmers, agricultural workers, experiment stations, road officials, and Department of Agriculture publications.

Long-term projected prices were derived from data furnished by the Agricultural Research Service and Agricultural Marketing Service, dated September 1957. Projected prices were used in all benefit computations as well as for operation and maintenance costs. Present (1962) prices were used for installation costs. The costs of all structural measures were amortized over a 100-year period, using three percent interest rate.

Landowners and operators having flood plain land were interviewed to

determine present land use and yield, anticipated land use and yield with various degrees of protection from floodwater and sediment damage, and percent damage by depths of inundation to crops and fixed improvements. This information was checked for reasonableness and summarized by evaluation reaches. Damageable values were derived from these summaries and from cost and price information.

Damageable values, stage-area relationships, and flood series were used in estimating average annual damage without and with project.

Benefits from restoration of former productivity and more intensive use were estimated on the basis of increases in net income due to the reduction of flood hazards. Associated costs and increased damages due to higher damageable values "after the project" were deducted from gross benefits of this type. Increased net returns of individual crops were discounted for lag in accrual where it was deemed necessary. The area on which restoration of former productivity and more intensive land use benefits are claimed is 1,498 acres. These benefits are in line with the capability of the flood plain land.

The local sponsoring organizations estimate the value of land, easements, and rights-of-way for structural measures at \$181,503. Included in this amount is \$3,500 for legal fees and local time spent in obtaining and recording easements.

Indirect damages were estimated to be ten percent of direct floodwater damage.

The following table shows the present and future conditions of the flood plain land benefited by structural measures.

SUMMARY OF ALL EVALUATION REACHESRestoration of Former Productivity and More Intensive Use Benefits

Present Conditions				Project Conditions			
Crop	Acres	Average Flood Free Yields	Net Returns	Crop	Acres	Average Yields	Net Returns
Pasture	235	3 AUM	\$2,151	Improved Pasture	749	9 AUM	\$20,562
Woods & Brush	1,799	\$1.50	2,699	Corn	682	65 Bu.	31,713
				Truck	67	200 Bu.	8,576
				Woods & Brush	536	\$1.50	804
Total	2,034	xx	\$4,850	Total	2,034	xx	\$61,655

Increased Net Returns	\$56,805
Discounted Difference in Net Returns	53,692 ^{1/}
Less Added Flood Damage	1,563
Less Development Cost Amortized	<u>7,518</u>
Average Annual Benefits	\$44,611 ^{2/}

^{1/} Increased net returns of individual crops were discounted for lag in accrual.

^{2/} Benefits from restoration of former productivity are \$37,588 on 1,263 acres and benefits from more intensive use of land are \$7,023 on 235 acres.

The soils of the flood plain are mostly Class IIIw with small areas of Class IIw and a moderate acreage of IVw. Floodwater retarding structure Number 12B will cover a good part of the Vw soils.

Benefits from the recreational use of the planned structures were estimated in accordance with Paragraph 1131.311-d of the Watershed Protection Handbook. These benefits are claimed as an incidental effect of the project. It is expected that landowners will make the recreational facilities at these structure sites available to the general public and organized groups on a fee basis. These structures will be located within easy driving distance of several populated areas surrounding the watershed. This area of the state has a good concentration of industry, mostly textile. Assistance in the appraisal of all the factors involved in estimating recreational benefits was obtained from the Soil Conservation Service Biologist for South Carolina. A fee of \$0.50 per visitor-day was used for all structures except numbers 9B and 12B. A fee of \$1.00 per visitor-day was used on these two structures because it is expected that more basic facilities will be provided. Non-project associated costs were deducted to obtain these project benefits. Recreation benefits are estimated to be \$16,280 annually. (Table 6)

Local secondary benefits were estimated in accordance with Paragraph 1131.312 of the Watershed Protection Handbook. The value of local secondary benefits stemming from the project were considered to be ten (10) percent of the direct primary project benefits. Indirect benefits were excluded in computing these secondary benefits. The value of local secondary benefits induced by the project were considered to be ten (10) percent of the increased costs that primary producers will incur in connection with increased production. Local secondary benefits are estimated to be \$15,286 annually.

The following table shows the details of calculating secondary benefits.

SUMMARY OF SECONDARY BENEFITS

Items	Dollars	Percent Factor	Average Annual Secondary Benefits
Direct Primary Benefits	63,430	10	6,343
Added Crop and Pasture Production Costs	80,336	10	8,034
Annual Associated Costs	9,093	10	909
TOTAL	xxx	xxx	15,286



34° 45'

34° 40'

LATITUDE AND LONGITUDE LINES
ARE APPROXIMATE

82° 45'

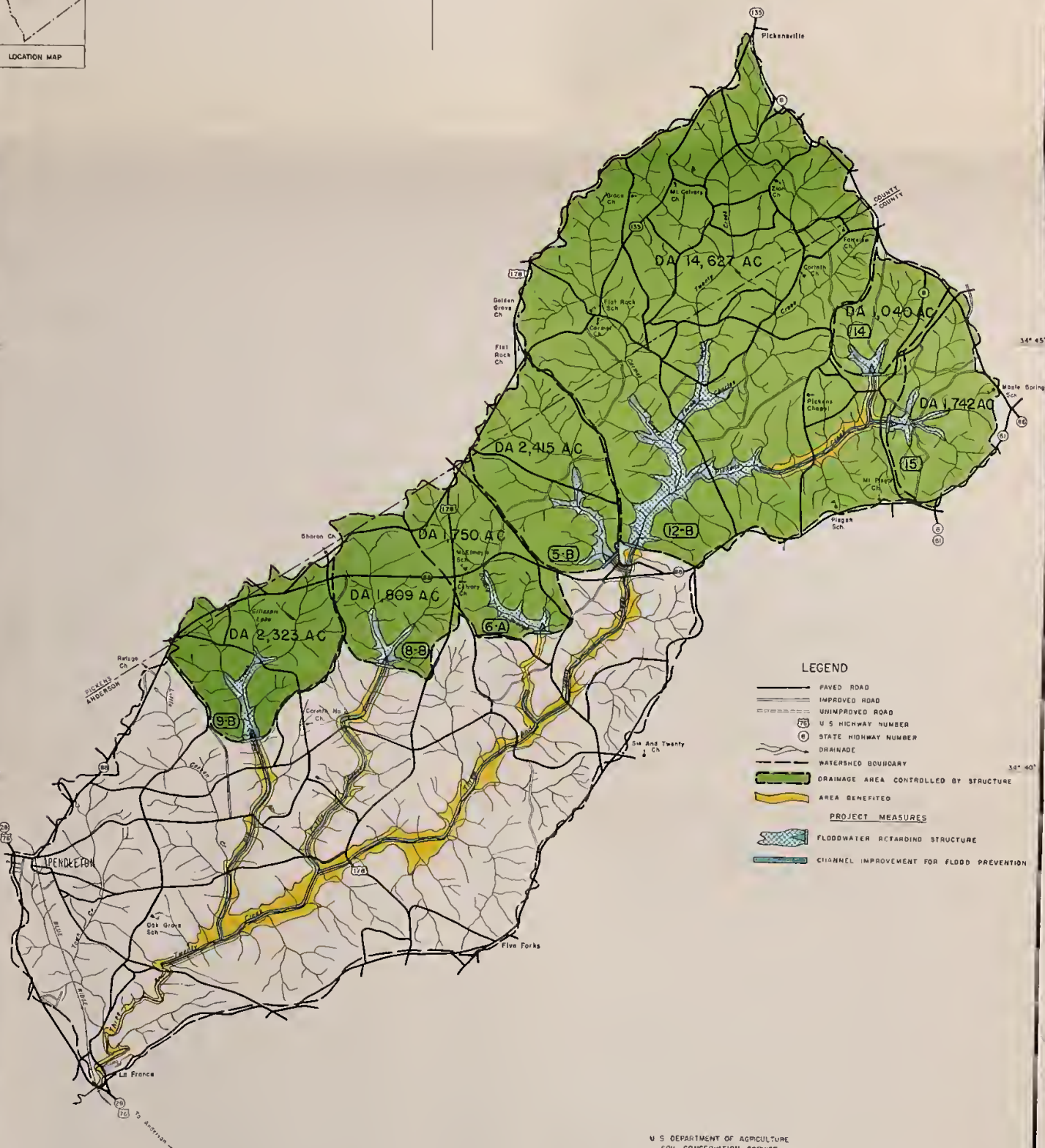
82° 40'

82° 35'

34° 45'

34° 40'

82° 35'



LEGEND

- PAVED ROAD
- IMPROVED ROAD
- UNIMPROVED ROAD
- U S HIGHWAY NUMBER
- STATE HIGHWAY NUMBER
- DRAINAGE
- WATERSHED BOUNDARY
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- AREA BENEFITED
- PROJECT MEASURES
- FLOODWATER RETARDING STRUCTURE
- CHANNEL IMPROVEMENT FOR FLOOD PREVENTION

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PROJECT MAP THREE AND TWENTY CREEK WATERSHED ANDERSON AND PICKENS COUNTIES SOUTH CAROLINA

0 1/2 1 1/2 2 MILES
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